Annals of Tropical Research 29(1): 39-48 (2007)

Compiling a GIS Database of Tree Farms on Leyte Island

Melissa Gordon[1] and Samuel Bernaldez[2]

[1]School of Natural and Rural Systems Management,
The University of Queensland, Gatton 4343, Australia
[2]College of Forestry and Natural Resources,
Leyte State University, Visca, Baybay, Leyte, the Philippines

ABSTRACT

As part of ACIAR project ASEM/2003/052, *Improving Financial Returns to Smallholder Tree Farmers in the Philippines*, plantations of timber trees in Leyte Island the Philippines were located using a systematic survey of the island. The survey was undertaken in order to compile a database of plantations which could be used to guide the planning of project activities. In addition to recording a range of qualitative and quantitative information for each plantation, the survey spatially referenced each site using a Global Positioning System (GPS) to electronic maps of the island which were held in a Geographical Information System (GIS). Microsoft Excel and Mapsource® software were used as the software links between GPS coordinates and the GIS. Mapping of farm positions was complicated by different datums[1] being used for maps of Leyte Island and this caused GPS positions to be displaced from equivalent positions on the map. Photos of the sites were hyperlinked to their map positions in the GIS in order to assist staff to recall site characteristics.

Keywords: global positioning system, World Geodetic Datum 1984, North American Datum 1927

INTRODUCTION

One of the most useful characteristics of GIS software for land management has been the ability to link shapefiles[2] of map features (points, lines and polygons) to qualitative attribute data in a database so that the data can be analysed, symbolised and displayed in relation to their location (Yule *et al.* 1996; Müller and Zeller 2002). The data may be in numeric or alphabetic format, e.g. as dates, geographic characteristics

[1] A datum is a set of geometric and numeric constants from which other quantities such as coordinate systems can be defined. A datum defines a reference surface, e.g. the surface of the earth.

[2] A *shapefile* is a vector data storage format for storing the locations, shapes and attributes of geographic features.

such as elevation, coded to represent land use classes or as written comments. In recent years, this capability has been enhanced by software import and export modules which allow the transfer of files between GIS software such as the ESRI[3] suite of programs and Microsoft Excel and Access. This has enabled the capture of data in the field with simple GPS units and subsequent download, export and upload into a GIS. While requirements for more complex data analysis may warrant formatting features and attribute data into a geodatabase[4], more often the ability to store, display and sort data is sufficient to generate thematic maps which are useful for many day to day requirements. Because any map feature in a GIS is automatically linked to an attribute table, it is a simple matter to display the attribute data on thematic maps and to establish hyperlinks to photographs and other graphics. These maps are easy to print or can conveniently be emailed as an attachment.

Recent versions of proprietary GIS software are user-friendly and can be operated by staff with limited training. This makes the creation of a database feasible with equipment as limited as a GPS, a notebook computer and a digital camera. For projects such as ACIAR project ASEM/2003/052, where the location and a description of small-scale forest plantations on Leyte Island was required, the creation of a database initially appeared to be a complex task because little about the number, location and nature of the plantations was known. These plantations are called 'tree farms' and they are scattered over the island. This paper discusses the methods used to undertake a ground survey to record the position of tree farms and incorporate information about them into a database which could be accessed using GIS software. The procedures for creating the database are described and issues involved in using outdated map files are discussed.

SURVEY METHOD

Records of registered tree farms[5] were obtained from Community Environment and Natural Resources Offices (CENROs) and these were used to guide the search for tree farms on the island. These records were incomplete, but they indicated where tree farms were most likely to be found, rather than requiring survey staff to search the entire island. In municipalities where records on tree farms were not available, information was obtained through the help of the Municipal Agriculture Officer (MAO). Where possible, the owners of the tree farms were interviewed and information about the tree farm was obtained using a semi-structured survey (Appendix 1). The survey was designed to collect biophysical data about the trees and information about tree establishment practices, silviculture and costs.

[3] ESRI is the acronym for the Earth Science Resources Institute a company which markets the ArcGIS suite of GIS software in the USA.

[4] A geodatabase includes the display of features (i.e. as a map) and hosts attribute data concerning these features within a relational database management system.

[5] It is a legal requirement that logs can only be sold from tree farms which have been registered with the Department of Environment and Natural Resources.

As a courtesy and for safety reasons, upon entering the community, a personal visit was made to the *barangay*[6] captain or councillors to make residents aware of the survey before ACIAR staff field work commenced. An introductory letter was also given to the barangay captain which introduced the researcher and explained the aims of the project. This procedure proved most helpful in obtaining information about the location of tree farms within the barangay. During interviews, the multi-lingual skills of ACIAR field interviewers were needed to translate questions into the local dialects of Cebuano and Waray Waray.

Recording GPS Positions and Transfer to the GIS

For other project workers to be able to use the results of the survey, a database was required which linked each tree farm position to a range of qualitative and quantitative attribute data which were recorded for each farm. To accomplish this, tree farm positions were recorded using a hand-held global position system (GPS), downloaded using Mapsource® software and then imported into Microsoft Excel. Data were then incorporated into the Excel file and the file was exported to the ArcGIS® suite of software modules so that tree farm positions and attribute information could be displayed using ArcMap™.

The coordinates of the tree farms were recorded with a Garmin 76 hand-held GPS. Although GPS accuracy varies depending on canopy cover, terrain and atmospheric conditions (Kevany 1994) and the number of satellites that the unit can receive (Li *et al.* 2005), the display panel of the GPS indicated that horizontal positional location was within +/- 10 m for most points collected in the survey. For the purpose of this survey, this degree of accuracy was considered acceptable. Tree farm position coordinates were referenced to the World Geodetic Datum (WGS84) which is in current use throughout much of the world. Unfortunately, the datum used in all of the available shapefiles of Leyte Island is the North American Datum 1927 (NAD1927) although this datum is out of date. Data were collected using the Universal Transverse Mercator (UTM) projected coordinate system[7] which references locations in metres. The shapefiles of Leyte use a geographic coordinate system (latitude and longitude) and these were transformed using Arc ToolBox® software to the WGS84 datum and a UTM projection. The shapefiles had been supplied with little supporting documentation concerning their provenance or age and using these shapefiles was not entirely successful because some of them lacked detail, some roads were missing and some new major roads or highways have since been established.

A digital camera was used to photograph the sites and the photos were hyperlinked into ArcMap®. These photos were used as a means of providing visual information about the site.

---

[6] Each municipality is divided into smaller communities or *barangays* which encompass a village. Barangays are the smallest political unit in the Philippines.

[7] Projected coordinate systems represent the earth as a flat surface and positions are referenced in Cartesian ‘x’ and ‘y’ coordinates.

SURVEY RESULTS AND GIS DATABASE

Data collection was constrained when tree farm owners were not available during the field visit. ACIAR staff were able to interview the owner in only 36 of the 71 sites visited. Farmers were also generally reticent with information concerning their tree farms and appeared to have little knowledge of tree establishment and silvicultural techniques. However, a basic description of the stand was obtained for most sites. Also, DENR staff acknowledged that the records of registered tree farms were not complete and that farmers often register their trees just before harvesting. This resulted in some young plantations not being included in the lists of tree farms which were obtained from DENR. Young plantations are difficult to see from the road and the sample of tree farms may be biased towards older, more visible plantations. The end product of the survey was a map of the tree farm which were found (Figure 1), overlaid onto a shapefile of the roads in Leyte. Qualitative and quantitative data describing each tree farm were contained in an attribute table linked to the shapefile of each tree farm.

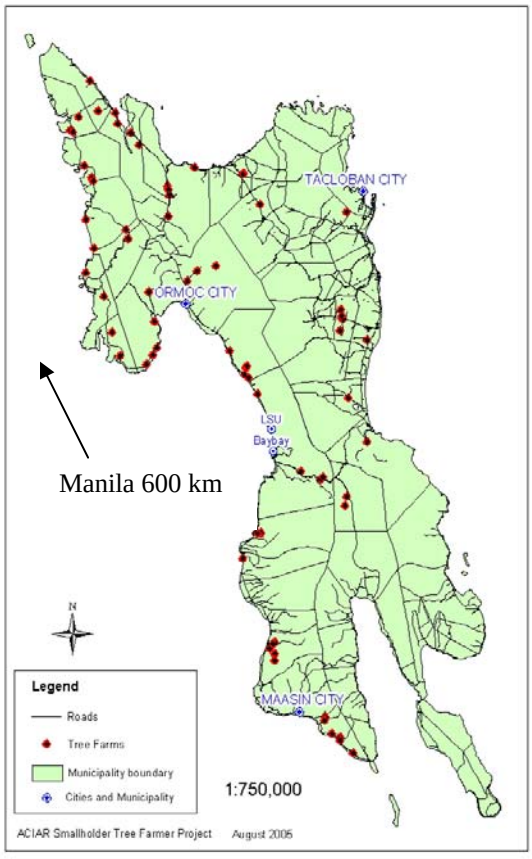

Figure 1. Location of 71 tree farms on Leyte Island

Position locations were collected by the GPS as *waypoints* (i.e. marked points) in UTM map coordinates. The discrepancy in the datum used by the GPS (WGS84) for the waypoints and the datum used by the shapefiles became apparent when the waypoints were overlaid onto the shapefiles which used a NAD1927 datum. To test how closely the GPS track would overlay onto a shapefile of Leyte roads, ACIAR staff travelled along a road with the GPS, downloaded the file of its path and superimposed the path onto a shapefile of the island's roads. The path recorded by the GPS was approximately 150 m to the east of the road (Figure 2). Transforming the shapefile datum to WGS84 resulted in a slightly closer overlay of the GPS track along the road, but because the shapefiles had been digitised from maps dating from the 1950s at a scale of 1:250,000, no further improvements were possible.

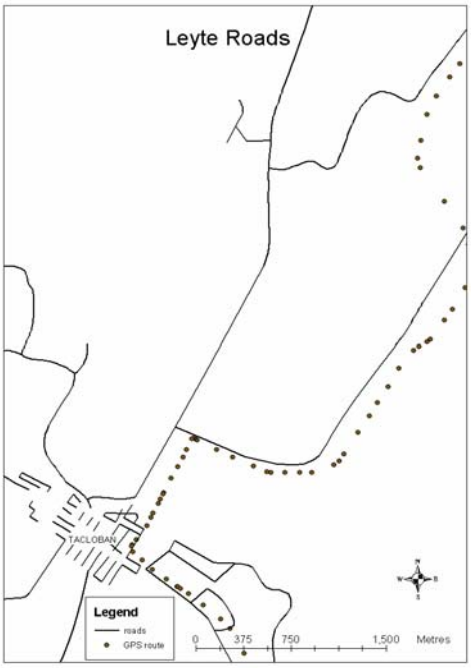

Figure 2. GPS track created while travelling on a highway in Leyte with the roads projected using the NAD 1927 datum and the GPS data projected using the WGS84 datum

DISCUSSION AND CONCLUSION

The GPS referencing of the tree farms was a quick and simple way of recording tree farm positions and qualitative information was easily added using Microsoft Excel. This has allowed the database to be used for other project activities. The datum differences between GPS positions and the shapefiles were only partly corrected by transforming the shapefile and for improved accuracy it may be preferable to re-map

the roads of the island rather than persist with using old shapefiles of unknown provenance.

Because the information contained in the attribute table of each tree farm is linked to its position, spatial modelling of these attributes is now possible. This may allow the influence of attributes such as tree age, species silvicultural management to be modelled for various locations in the island. Also, the database can be updated and edited. Another extension of the database is the hyperlinking of photos of some of the important sites, to allow ACIAR project personnel to gain an appreciation of site without visiting them in the field. In particular, this project has shown that the use of GPS and GIS technology provides opportunities for storing and analysing data in a way that was not previously readily available in Leyte. However, any further development of the database would ideally be linked to concurrent investment in accurate shapefiles which use the WGS84 datum so that the analysis of attribute data is correctly geo-referenced.

REFERENCES

KEVANY, M.J. 1994. Use of GPS in GIS data collection. *Computer, Environment and Urban Systems*. **18**(4): 257–263.

LI, J., TAYLOR G. and KIDNER, D.B. 2005. Accuracy and reliability of map-matched GPS coordinates: The dependence on terrain model resolution and interpolation algorithm. *Computers and Geoscience.* **31**(2): 241–251.

MULLER, D. and ZELLER, M. 2002. Land use dynamics in the central highlands of Vietnam: A spatial model combining village survey data with satellite image interpretation. *Agricultural Economics,* **27**(3): 333–354.

VINNENNEAU, A. 2001. *Using ArcCatalog.* ESRI, Redlands, California.

Appendix 1. Questionnaire for tree farmers

CENSUS SURVEY FOR POTENTIAL TREE PLANTATIONS FOR STUDY/DEMONSTRATION PURPOSES

Place of interview: _____ Date: _____
Enumerator/s: _____
Respondent no.: _____

A. Background information

1. Name of the owner:
2. Home address:
3. Description of the plantation:

Species	Area	Spacing	Stocking	Age	Topography	Location
:						
:						

4. Farm accessibility:
   b. Distance of household to farm: _____
   c. Distance of nearest formed road to farm: _____
   d. Distance of farm to DENR nursery or office: _____
   e. Accessibility of 4WD road for log removal: _____

B. Timber production system

1. What are your intentions or reasons/purposes for planting trees?
_____
_____

2. Are your trees registered? Why or why not?
_____
_____

3. Source (s) of planting materials:

4. Labour requirement:

a. Establishment and maintenance:

Activities	Methodology	Cost	Other comment (s)
1. Land preparation			
2. Lay-outing			
3. Staking			
4. Hauling			
5. Digging/planting			
6. Ring weeding			
7. Brushing			
Others			

b. Silviculture

Silvicultural treatments						
Pruning		Thinning		Fertilizer		
When	Uses of pruned materials	When	Uses of pruned materials	What	How much	When
:						
:						

c. Value of the stand for silvicultural demo plots

C. Willingness to work with the project

1. Are you willing to welcome any technologies that the project may introduce to you? _____

Why or why not?

_____

2. Are you okay if the project applies/tests its technology directly to your tree farm/plantation? ____

If no, a.Why?

_____

b. Are you contented with the status or performance of your trees now? _____

If yes, any agreements you want with the project?

_____

D. Information about neighbouring farms

Name of the owner	Location
:	
:	